EXPORTIT MARKET BRIEF: INTERNET INFRASTRUCTURE

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This paper will give a brief overview of the Internet backbone and the Next Generation Internet.

The Internet is a disparate association of networks and millions of computers across the world. The main lines that carry the bulk of the Internet traffic is collectively called the Internet backbone. The backbone consists of fiber-optic lines owned by the major networks in the system which are owned by the major Internet service provides such as AT&T, Genuity, PSINet, Cable & Wireless, Worldcom (UUNet).

Levels of Access:

For a rational image of the Internet we can divide the topic into five categories or levels, there are exceptions to this outline.

Level 1: Interconnect Level-NAPS
Level 2: National Backbone Level
Level 3: Regional Networks
Level 4: (Consumer) Internet Service Providers
Level 5: Consumer and Business Market

At the top of the of this list is the Network Access Points (NAPs) where major backbone operators interconnect to establish the core concept of an Internet.

Background:

The backbone in the United States has been developed to ensure that there are many intersecting point that ensure that if one part of the network slows down another will pick up the slack, this is know as redundancy.

In the United States, there are five original points-San Francisco, San Jose, Chicago, NewYork and Washington, DC–where the main lines intersect. New points are being added every year.

Internationally, points exist in Tokyo, Seoul, Singapore, Hong Kong, Sydney, Auckland, London, Paris, Frankfurt, Amsterdam, Madrid, Milan, Geneva, Vienna, Stockholm and Copenhagen.

These points are called Network Access Points (NAPs) and Metropolitan Area Exchanges (MAEs).

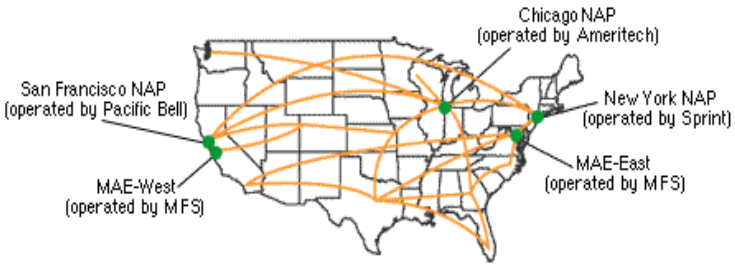

Figure 1: The U.S. commercial backbone and major Internet connection points

Network Access Points are exchange points for Internet traffic. ISPs connect their network to NAPs to exchange traffic with other ISPs. The exchange of Internet traffic is generally referred to as peering. NAPs utilize ATM Cell Relay Technology[2] which allows ISPs to interconnect and exchange traffic among themselves.

Backbone companies own or lease national or international high-speed fiber-optic networks that are connected by routers, which the backbones use to deliver traffic to and from their customers. Many backbones are vertically integrated, functioning as ISPs by selling Internet access directly to end users, as well as having ISPs as customers.

Point of Presence is another important part of the Internet's infrastructure. A Point of Presence is a site where there exists a collection of telecommunications equipment, usually modems, digital leased lines and multi-protocol routers. An Internet access provider may operate several PoPs distributed throughout their area of operation to increase the chance that their subscribers will be able to reach one with a local telephone call. The alternative is for them to use the virtual PoPs via some third party.

The most frequent method used by business and large organizations to access the Internet is through a T-1 Carrier. A T1 is a term for a digital carrier facility used to transmit a DS-1 formatted digital signals at 1.544 megabits per second. This is made up of 24 digital channels. The T1 requires a digital connection device (CSU/DSU)

The T1 is like a large water main that serves a city, a large amount of water or traffic flow through it, making the T1 the major carrier of Internet traffic. The T1 connects that backbone provider to the ISP provider via the telco.

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[2]Asynchronous Transfer Mode: A transfer mode in which the information is organized into cells. It is asynchronous in the sense that the recurrence of cells containing information from an individual user is not necessarily periodic.

T1 is connected via a high bandwidth digital circuit operating at 1.536 Mbps, or one sixth the speed of Ethernet, the most common way to connect a LAN to the rest of the world.

Results of Internet Growth:

In the past five years, the Internet has experienced unprecedented growth rates. The market for Internet backbone services has grown since privatization in 1995 into a market with a multitude of competing providers. Figure one shows that, according to *Boardwatch* magazine, there are forty-two national backbones, a number that has been rising steadily since the Internet was privatized.[3] *Boardwatch* defines a national backbone to be one "maintaining a hub city in at least five different states, spanning both coasts, and peering at the major NAPs."[4] The list of national backbones includes the top-tier backbones that only peer with other backbones, as well as other smaller national backbones that peer with some backbones and purchase transit from others.

The list of national backbones includes a number of backbones that pre-date the privatization of the Internet, as well as many newer players that have entered partly on the strength of their new fiber facilities. Many of the older backbones have been swept into the merger wave that is now transforming the information technology and communications industry, and, combined with their merger partners, remain among the largest backbones. WorldCom now owns UUNET and ANS Communications, two of the earliest backbones, along with GridNet, Unicom-Pipex, InNet, NL Net, and Metrix Interlink. UUNET, in turn, owns MFS Communications, which runs the NAPs known as MAEs, including one of the original NAPs, MAE East. According to the Department of Justice, UUNET is now "by far the largest provider of Internet backbone services in the world, whether measured by traffic or revenues." In 1997, GTE Internetworking, since renamed Genuity, purchased BBN, the developer of a precursor to the modern day Internet, and was then spun off as a separate public corporation. AT&T's role in the backbone market has grown with its purchases of CERFnet, another early backbone, along with IBM's Global Network business. Cable & Wireless entered the ranks of the largest backbones when it purchased MCI's Internet backbone, which was divested during the MCI WorldCom merger proceeding.[5] Finally, PSINet, an early backbone that has remained independent, also remains among the list of the larger backbones.

The increase in the number of backbones has been facilitated by the recent dramatic increases in the availability of fiber optic capacity. Figure five shows that, not only have the fiber networks owned by the incumbent carriers -- AT&T, Sprint, and MCI WorldCom -- all grown in recent years, a more significant increase in capacity comes from four entrants -- Qwest, Broadwing (formerly IXC), Williams, and Level 3 -- that have built or are building nationwide fiber optic networks. Not only are these four companies themselves national Internet backbones, but a number of other backbones have in turn bought or leased capacity from them. For instance, PSINet purchased sixteen fibers covering 14,000 miles from the former IXC Communications.[6] Backbones also lease fiber capacity from facilities-based carriers. The development of dense wavelength division multiplexing (DWDM) technologies, which divide each strand of fiber into

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[3] *Boardwatch Magazine Directory of Internet Service Providers*, Vol. 2, Fall 1997, at 27. *See infra at* n. 67.

"With Series of Deals, PSINet seeks to become 'Super Carrier'," *Communications Daily*, Oct. 20, 1999.

multiple channels, is further increasing the availability of fiber capacity by multiplying the capacity of existing and new networks. Entry into the backbone market is facilitated by this increasing availability of fiber capacity from a growing number of providers.

The growth in private Internet backbones has coincided with the introduction of the World Wide Web, which has popularized the Internet for millions of consumers. The increasing popularity of the World Wide Web encourages the creation of more Web content, which in turn encourages additional users to log on to the Internet. Figure three shows the recent growth in the number of devices in the United States that can access the Web, while figure four shows the corresponding increase in the number of Web pages. New users, and new providers of content, require Internet access, encouraging the creation of more ISPs, which in turn encourages the entry of more Internet backbone providers and fiber providers to transport the additional data. These ISPs compete to attract new users and content providers in a continuation of the cycle that has led to the unprecedented growth level that characterizes the Internet.

Internet Access:

During the past three years the way people access the Internet has changed dramatically., . The days of dial-up only Internet access are behind long gone. People now have a variety of options which include; DSL, Cable, Satellite and Wireless..

Chart 1

Internet Usage Growth during 1st quarter of 2000

Dial-up ISP	46,695,000	+10%
Cable Modems	3,825,464	+44%
Internet TV	1,115,300	-.2%
DSL	1,678,200	183%
Total	51,637,442	11+%

Digital Subscriber Line (DSL):

DSL (Digital Subscriber Line) is a service that offers a faster Internet connection than a standard dial-up connection. DSL technology uses existing 2-wire copper telephone wiring to deliver high-speed data services to homes and businesses. DSL uses the existing phone line and in most cases does not require an additional phone line. This gives "always-on" Internet access and does not tie up the phone line. DSL offers users a choice of speeds ranging from 144 Kbps to 1.5Mbps. This is 2.5x to 25x times faster than a standard 56Kbps dial-up modem.

This digital service can be used to deliver bandwidth-intensive applications like streaming audio/video, online games, application programs, telephone calling, video conferencing and other high-bandwidth services.

DSL takes existing voice cables that connect customer premises to the phone company's central office (CO) and turns them into a high-speed digital link. Over any given line, the maximum DSL speed is determined by the distance between the customer site and the Central Office (CO). Most ISP's offer Symmetric DSL (SDSL) data services at speeds that vary from 144 Kbps to 1.54 Mbps, and now even faster up to 6.0 Mbps--so customers can choose the rate that meets their specific needs. At the customer premises, a DSL router or modem connects the DSL line to a local-area network (LAN) or an individual computer. Once installed, the DSL router provides the customer site with continuous connection to the Internet and use of the telephone at the same time. A customer most be no further than 12,000-20,000 feet from a Central Office. One downside to DSL service is the often confused arrangement of who to contact with technical problems. Since there are often three distinct entities involved in DSL installation, consumers are often left waiting for months for connection and many find it a challenge to locate human technical assistance. The three entities involved are; the local phone company, Covad and the ISP.[7]

This is one example of how DSL is provided to the consumer.

The Consumer chooses an ISP. ISP contacts Covad and Covad organizes all the equipment and connections needed to install your service, including ordering any additional phone lines if necessary. The local phone company will install the dedicated line at the location. Once you request DSL service, Covad works closely with the ISP and other organizations to orchestrate DSL set-up.

The most popular types of DSL service include:[8]

· IDSL ISDN Digital Subscriber Line: Generic term for a basic symmetrical service that uses digital modems to achieve speeds of up to 144 kbps in both directions over ISDN-loop equivalent distances (about one mile).

· ADSL Asymmetric Digital Subscriber Line: Digital modems attached to twisted pair copper wiring that transmit from 1.5 Mbps to 9 Mbps downstream (to the subscriber) and from 16 kbps to 640 kbps upstream, depending on line distance.

· HDSL High data rate Digital Subscriber Line: Digital modems on either end of one or more twisted pair wires that deliver up to T1 or E1 speeds. At present T1 requires two lines and E1 requires three.

· VDSL Very high data rate Digital Subscriber Line: Digital modem for twisted-pair access operating at data rates from 12.9 to 52.8 Mbps with corresponding maximum reach ranging from 4500 feet to 1000 feet of 24 gauge twisted pair.

DSL Benefits

Always-On Service

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[7] http://www.buysellxchange.com/news/dsl_redback.asp
[8] http://www.buysellxchange.com/news/dsl_redback.asp

Phone/Internet Simultaneously
Up to 25x Times Faster Than Dial-up Modem
Cost Effective
No More Busy Signals
No More Dropped Connections
Faster Downloads
Faster Games
Multiple Computers on Single DSL Line
Dedicated Connection & Speed

DSL Providers- 2000[9]

Operator	**Customers**
SBC	516,000
Verizon	350,000
Covad	274,000
BellSouth	134,000
US West	250,000
Northpoint	87,300
Rhythms	67,000
Total	**1,678,200**

Internet Access via Cable:

As illustrated in **Chart 1**, Internet access via cable is an increasingly popular means to access the Internet. Cable companies claim that cable modems are about 100 times faster than a dial-up Internet connection, running at an ultra-fast speed of 5 million bits per second (mbps). While this speed is achievable, many consumers actually experience connection speeds closer to 1 mbps or 20 times faster than a typical 56,000 bps dial-up connection. Nevertheless, cable access provides an easy, faster way to access the Internet than dial-up modems.

[9] http://www.point-topic.com/dslprojs.html

Like DSL, Cable modems allow for a 24 hour Internet connection.

The local cable company is responsible for installing the cable modem and managing the quality of service. At the cable company's main network office the user is connected to the cable ISP's national backbone. The ISP actually provides the Internet connectivity, while the cable company provides technical support.

Chart 2

Cable Modem Customer Rankings as of September 30, 2000

Operator	**Customers**
AT&T	888,000
Time Warner	719,000
Cox	398,816
Comcast	303,600
Shaw	302,000
Rogers	300,400
Charter	184,600
Cablevision	139,700
Videotron	108,000
Cogeco	74,000
Adelphia	100,000
RCN	52,348
Other	255,000
Total	**3,825,464**

The main difference between Cable and DSL is that DSL provides a dedicated connection over a single phone line, while cable connections run over a dedicated, but shared, medium. Therefore, although cable connections have greater bandwidth capabilities, you have to share that bandwidth with others in your geographical area, which may slow your connection and loading speeds. In addition, it is important to be aware that in order to provide widespread cable access, cable companies will have to complete major upgrades and add features such as fiber optics and specialized two-way equipment. In contrast DSL service operates on lines that are already installed and available to practically every home and office in the world.

According to a report by Allied Business Intelligence (ABI), at the end of last year there was a total of 2.1 million U.S. cable modem subscribers versus a half a million DSL subscribers. ABI's report, "Cable Modems Worldwide: High Speed Internet Access Over Cable Networks," said that subscribers to data over cable services will increase from 3.3 million subscribers worldwide to 58.6 million by 2005.[10]

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[10] *Cable modems Worldwide: High Speed Internet Access Over Cable Networks*

The U.S. is the leader in cable modem subscribers, which ABI predicted would jump from last year's 2.1 million users to 14 million by 2005.

Other regions experiencing growth in cable Internet access are South Korea as well as France and Germany. European countries like Spain and Latin America are lagging behind because they have underdeveloped cable systems.

While ABI gives cable modems the edge over DSL in the residential market, a survey by eMarketer said that DSL would overtake cable modem access by 2003. EMarketer predicts that there will be 32 million broadband users by 2003, with 10.95 million subscribers using DSL.

Satellite Internet Access:

The demand for satellite capacity for IP traffic has been growing exponentially over the past few years. Over 11% of the world's ISPs now use a satellite link to connect to a Internet backbone. Figure 7 illustrates the dramatic increase in value of IP over Satellite Market in the past three years. New supply side drivers which look set to drive the Internet via satellite industry forward include business-to-business e-commerce and rural communications. According to the 2000 Internet via Satellite report, the major geographic areas for growth for ISP links have been in Central and Eastern Europe, Turkey, Israel, Australia, South America and South Africa. Hybrid services have seen most of their growth in geographic areas close to the core of the Internet such as the United States and Western Europe.[11] Figures 9 and 10 diagram how Satellite Internet reaches the consumer.

The Future of Internet Infrastructure:

3G Wireless

3G wireless is the third generation of wireless communications following analog and digital. 3G will emerge as the MultiMedia generation of wireless communication which will allow for higher speed data transfer allowing new video, audio and other multimedia applications. 3G will offer broadband mobile communications with voice, video, graphics, audio and other information. The information is split into separate but related packets before being transmitted and reassembled at the receiving end.

With Third Generation (3G), the information is split into separate but related "packets" before being transmitted and reassembled at the receiving end.

Speeds of up to 2 Megabits per second are achievable with 3G. The data transmission rates will depend upon the environment the call is being made in- it is only indoors and in stationary environments that these types of data rates will be available. For high mobility, data rates of 144 kbps are expected to be available- this is only about three times the speed of today's fixed telecoms modems.

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11 *Internet via Satellite 2000 Management Summary*, DTT Consulting, Hampshire UK

3G will bring one worldwide standard.

Third Generation (3G) facilitates several new applications that have not previously been readily available over mobile networks due to the limitations in data transmission speeds. These applications range from Web Browsing to file transfer to Home Automation- the ability to remotely access and control in-house appliances and machines. Because of the bandwidth increase, these applications will be even more easily available with 3G than they were previously with interim technologies such as GPRS.

Japanese network operators will be the first to implement 3G networks in the year 2001, and Japanese terminal manufacturers, who have not had much market share outside their home market, will be first with 3G terminals.[12]

Next Generation Internet:

On October 1996, the Clinton Administration announced its support for the Next Generation Internet (NGI). This initiative provided funding to academic, government, and industry researchers to advance research into experimental network applications, services and infrastructure.

The NGI will enable the development of high-performance test networks among research centers to "provide system-scale testing of advanced services and technologies and to support testing of advanced applications." Two NGI goals are to develop a broadly based network that will connect research institutions across the country at end-to-end performance speeds 100 times that of the current Internet and to develop an ultra-high speed network among a select group of institutions that will function at speeds 1000 times faster than current Internet.

This project comprises 180 U.S. universities and government and industry partners that have joined to develop advanced Internet technologies and applications. The primary objectives of the Internet2 project are to create and sustain a leading-edge network capability for the national research community; direct networking development efforts that result in a new generation of applications that will fully exploit the capabilities of broadband networks media integration, interactivity, and real-time collaboration; and integrate with continued efforts to improve Internet services for all members of the research community, and eventually the worldwide Internet community.

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[12] Http://www.mobile3g.com